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Difficulties in controlling mobilization pain using a standardized patient-controlled analgesia protocol in burns

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Abstract

Objectives: The aim of the study was to evaluate pain relief for patients with burns during rest and mobilization with morphine according to a standard protocol for patient-controlled analgesia (PCA).

Methods: Eighteen patients with a mean (SD) burned total body surface area (TBSA %) of 26 (20) were studied for 10 days. Using a Numeric Rating Scale (NRS, 0=no pain and 10=unbearable pain), patients were asked to estimate their acceptable and worst-experienced pain by specifying a number on a scale, and at what point they would like additional analgesics. Patients were allowed free access to morphine with a patient controlled-analgesia pump device (PCA). Bolus doses were set according to age; $(100-\text{age})/24 = \text{bolus dose (mg)}$, and 6 minutes lockout-time. Degrees of pain, morphine requirements, doses delivered and demanded, oral intake of food, and anti-emetics given were used as endpoints.

Results: Acceptable pain (mean (SD)) was estimated to be 3.8 (1.3) on the NRS scale, and additional treatment was considered necessary at scores of 4.3 (1.6) or more. NRS at rest was 2.7 (2.2) and during mobilization 4.7 (2.6). Required mean morphine/day was 81 (15) mg and number of doses requested increased during the first six days after the burn. We found no correlation between dose of morphine required and any other variables.

Conclusions: Background pain can be controlled adequately with a standard PCA protocol. During mobilization, the pain experienced was too intense, in spite of having the already high doses of morphine increased. The present protocol must be refined further to provide analgesia adequate to cover mobilization as well.

Word count: 257

Key words

Burn, pain, NRS, morphine, patient-controlled analgesia

Introduction

Treatment of pain for patients with burns is still challenging. The severity of pain after a burn is difficult to treat.¹⁻⁴ A visual analogue scale (VAS) score of < 3 has been used as an acceptable measure of pain in patients with burns.⁵ However, such a result seems difficult to obtain in the care of burns⁶⁻¹⁰, although opioids form the basis of treatment. As has previously been reported, neither the total burned area (TBSA%)^{1 6 9 11}, nor the burn depth, correlates with the reported pain. Pain is highly variable among patients and even within individuals throughout a given day or from one day to another¹⁰, and it is also related to the burn care procedures..⁷

The care of burns has changed substantially during the past decade, with early primary excision and grafting, possibly altering the amount of pain experienced by the patient. Simple but adequate protocols for the treatment of pain are therefore required. Unfortunately, there are however, few available suggestions for detailed dosage that at the same time have been correlated with pain scores by the patient. Such scores must also be related to what each individual patient considers acceptable, and when they demand additional treatment.

Our aim was to investigate if a pain treatment protocol constructed for use for postoperative pain after major surgery (abdominal, gynaecological, thoracic, and limb/spinal surgery)¹² could be used also for pain control after burn injuries. We put forward the following hypothesis: a standard protocol, adjusted for age, for patient-controlled analgesia with morphine, which has proved to be sufficient for postoperative pain, is also adequate for burned patients during rest and mobilization.

Patients and method

We obtained informed consent from each patient and approval from the local ethics committee. Eighteen consecutive patients with burns and severe pain were included. Those with difficulties in communication as a result of psychiatric disorders, language problems, or prolonged ventilation were excluded. Characteristics of the patients are shown in Table 1.

Table 1. Characteristics of the patients

Age (years)	35 (13.5)
Male:Female	12/6
Weight (kg)	82 (14.5)
TBSA (%)	26 (20.0)

Data expressed as mean (SD) or N.

Evaluation of pain

Intensity of pain was assessed using a numeric rating scale (NRS), by which patients scored their pain, giving a number on a scale on which 0 represented no pain and 10 the worst pain imaginable. The NRS has the same sensitivity and is equal to the visual analogue scale (VAS)¹³⁻¹⁵, but is easier to use when patients have difficulties in manipulating the VAS.

On admission patients were asked to describe the worst pain that they had previously ever experienced, the intensity of pain that would be acceptable during the prevailing circumstances, and the degree of pain that would make them request additional medication. This was done to accustom them to the NRS and to make it possible to set the pain in the context of their previous experiences.

Pain was recorded on admission and every third hour thereafter when the patient was awake.

During mobilization, the NRS was recorded every fifth minute. A mean (SD) value for pain at

rest and during mobilization was used to describe the pain experienced by each patient each day. Treatment of the burned patients during hospital care consists of ambulation from the bed, and physical motion/therapy at the ward, all of which were performed according scheduled routines. These activities are referred to, in this investigation as mobilization activities. Regular wound care, and dressing changes was done by anesthesia staff administered sedation or by patient controlled sedation as we have previously described for this particular unit³⁰ and were not included in the present pain evaluation and investigation. All patients experienced this type of care during their hospital stay.

Analgesics

Non-pharmacological strategies for treatment of pain were used as distractions with music chosen by the patient, and letting the patient set the pace of mobilization.

All patients were given acetaminophen 15 mg per kg four times daily.

Morphine was given intravenously to all patients through a PCA (patient controlled analgesia) device (CADD Prizm, PCS, Deltec Inc, Saint Paul, USA). The initial bolus dose (mg morphine) during rest was $((100 - \text{patients age})/24)$.¹² Doses were given only on request, and no continuous infusion of morphine was given. During mobilization the bolus dose was doubled on demand. The patients were instructed to use the PCA device in order to control their pain, and to push the delivery button on their own. Information of two strategies in pain management was given and they were informed to practice both: Firstly, to demand enough doses in order to treat ongoing acute pain (at a pain level considered unacceptable) and secondly to try to demand doses prior an anticipated painful situation (for example, ambulation from the bed). Loading doses, as described in the original protocol, was therefore not used. Lock-out time on the PCA was set to six minutes, and it was possible for the patient to obtain a dose 10 times per hour. For example, bolus dose for a patient aged 28 years is

calculated as $(100-28)/24 = 3$ mg per bolus dose. Maximum dose of morphine were 30 mg per hour and 720 mg per 24 hours.

The pump recorded when a dose was given and also when a dose was requested but not delivered. If the number of requested doses was 20% higher than the number of doses given the bolus dose was increased by 50%.¹⁶. Three types of data from the devices were, recorded and analyzed: given doses, requested (but not provided) doses and doses of morphine in mg.

Side effects

Complaints of nausea or vomiting were recorded. If the patient complained of nausea more than once, antiemetic drugs were prescribed regularly in the form of metoclopramide (Primperan[®], Tika läkemedel AB, Sweden). If this was not sufficient dicyclanil (EsuposTM, UCB Pharma AB, Sweden) was given. If symptoms of nausea and vomiting persisted, granisetron (Kytrel, Smithkline Beecham AB, Sweden) was given. Doses were recorded. All oral food taken was recorded and amounts described as energy calculated in KJ (and kcal).

Active mobilization with and without a physiotherapist took place several times every day. Wounds were dressed with paraffin gauze (Jelonet[®], Smith & Nephew), followed by silver sulphadiazine (Flamazine[®], Smith & Nephew) and dry gauze. Dressing changes were not examined in this study.

Statistics

Values are given as mean (SD). Multiple regression analysis (Statistica, Statsoft Inc, USA) was used to evaluate correlations between doses of morphine and age, sex, pain, and TBSA %. Any change of dose of morphine and differences in NRS over time (days) was assessed by analysis of variance (ANOVA); probabilities of less than 0.05 were accepted as significant.

Results

On admission, a mean (SD) intensity of pain for the eighteen patients was recorded at 3.6 (3.5). Acceptable pain (without medication or after pain treatment) as described by patients on admission was 3.8 (1.3) and need for additional analgesics was claimed if the intensity increased to more than 4.4 (1.2). The worst previously experienced pain was described as 8.6 (1.6). During the study period patients had an acceptable level of pain at rest, according to their own standard, with a mean NRS of 2.7 (2.2) on day one and less than that on subsequent days. During mobilization the mean NRS was 4.7 (2.6). The mean NRS during mobilization was significantly higher than at rest ($p < 0.001$). All patients experienced more pain (NRS) during mobilization, than the previously set acceptable score on day one during the study period. Five patients estimated their background and mobilization pain to be higher than acceptable for two days or more.

Mean morphine dose (mg) delivered by the PCA system, for all patients, rose during the first six days ($p = 0.03$), most rapidly during the first three days. On days 7 to 10, no further increase was noted. The number of doses demanded increased on day 8 ($p = 0.04$). Two ascending linear trends in mean daily morphine doses demanded were identified: first, a rapid increase during the first three days, followed by a slower increase from day four until day eight (Figure 1). The number of doses delivered did not increase to the same extent.

Mean dose of morphine delivered day 1 was 44.6 (32.0) mg (range 6-106), for the first three days 85.3 (52.4) mg (range 6 – 225), and 80.1 (54.2) mg (range 6 - 236) during the study period of ten days. Doses demanded in mg were respectively 56.1 (50.6) mg (range 8-203), 124.9 (131.1) mg (range 38-549), and 113.2 (94.4) mg (range 8 – 549). We found no

correlation between doses of morphine and TBSA, sex, age or pain levels (multiple regression).

Among the patients we identified three subgroups of patients who used the PCA device or experienced the intensity of pain differently: *High consumers* were defined as those who all required more morphine than the mean of 97 mg per day or 807 mg in total during the study period. The group with *high NRS* values were those who estimated their pain to be higher than the previously set acceptable limit, both at rest and during mobilization, for more than one day. We set the limit for two days or more, to exclude those who had just one episode of breakthrough pain. The third subgroup, *high ratio*, was represented by those who made several demands for each dose of morphine delivered. They presented a mean demand: delivery ratio of 1.5 or more, which is 0.3 over the limit when adjustment of the bolus dose was to be made, according to the preset protocol. The cut off limit was set at > 1.30 for the *high ratio* group. All details of pain and usage of pump device are presented in Table 2.

Few side effects were recorded. Two patients had their bolus doses decreased on day 6 and 8, because of the effect of morphine on alertness. All patients were eating without the need for a regular antiemetic. During the study period, mean daily oral dietary intake/patient/day was 2007 (681) kcal.

Discussion

A number of interesting conclusions can be drawn from the data presented: 1) if opioids are given, background pain for burned patients can be treated adequately. 2) the amount of morphine demanded was highly variable among patients and no prediction about the amount required could be made based on the size of the burned area (TBSA%), sex, age, or pain scores recorded. The data confirms some previously published results,^{2 17} but contradicts others^{1 18} 3) The mean on demand dose of morphine/day for these patients was in range of 26 - 225 mg, which is in line with what has been reported.¹⁹ 4) the amount of morphine required by these injuries is high, especially when you consider the short period of opioid usage. Even the small burns demanded surprisingly large doses of morphine to relieve their pain. Interestingly, some papers about pain in burns have described routines that provides significantly smaller doses of morphine^{6 20 21} and also that some gave even less than prescribed.^{21 22} 5) the pain relief provided for mobilization pain, was found to be insufficient, even though the bolus dose had been doubled or tripled according to the protocol. This raises concerns about the genesis or background of the pain experienced. Is it neuropathic, or morphine resistant? And how is it best treated? These issues should be dealt with in future research.

We identified three different and interesting patterns for the pain response and treatment profiles of these patients. Despite the small subgroups we think that this categorization of pain has value from a descriptive perspective in this study. One group was composed of patients who demanded high doses of morphine, even though their initial recorded pain or other characteristics did not differ from the rest. These, which we refer to as, *high consumers* may be the ones who are less sensitive to morphine. They had similar pain score registered compared with the rest of the patients but they used the PCS device more actively to receive

the effect they wanted.. We registered a second group who rated their pain on the *NRS higher* than the others. Interestingly, they did not have any other pain characteristic that differed from the others than the higher NRS, both at rest and during mobilization. Their use of morphine was in the lower range, which leads us to assume that they may have another way of rating their pain. Lastly, we categorized a group with *high demand:delivery ratios*. Importantly, their pain both during rest and mobilization was less than for the rest of the patients and their total dose of morphine was also in the lower range. This group we believe is the least skilled in taking advantage of the PCA device. To reach an acceptable degree of pain control, it may take several demands to optimize deliveries from the device. We know that the size of loading dose of morphine and the use of the pain scores during the first 30 minutes of post operative care are useful in assessing the pattern of response in managing the pain.²³ This supports an early and aggressive bolus dose adjustment strategy for PCA use. We assume that mobilization was associated with most of the ineffectual doses and pain during mobilization is complex. For example, anxiety is related to pain and anticipation of pain causes fear and anxiety, which may increase the perception of pain.²⁴ If patients learn that mobilization cause agonising pain, even massive doses of morphine may still not control the pain. Comparative studies on demand:delivery ratio are rare, and difficult to interpret because of differences in bolus doses and lock-out times used. However, demand:delivery ratios of 1.35 to 1.76 for postoperative PCA using morphine have been described²⁵ and 1.57 has been described for PCA after major abdominal operations²⁶. According to these data, our values seem low, although we use the term high ratio. The difference in ratio may be explained by our adjustment of the bolus dose by increasing it 50 % when ratio is >1.20. However, pain may still be intense although the values for demand:delivery ratios are decreased.²⁵ Interestingly, our *high ratio* group had lower pain scores than the *high NRS* group (Table 2).

Little data is available on strategies for pain control during mobilization. Our protocol was not effective in this respect and further protocol refinements are therefore needed. To improve the pain control the protocol can be changed, a different opioid can be used or additional drugs may be tried. Different delivery systems and types of opioids have been evaluated previously all showing similar difficulties in pain control. Intranasal PCS using fentanyl^{27 28} and target controlled infusion of alfentanil²⁹ presents mean NRS scores between 3.9 and 7.7. These results are consistent with our previous findings, using PCS (patient controlled sedation) with propofol and alfentanil for dressing changes where we found a mean VAS at 4.9 (2.4).³⁰ Presumably there are predictors other than age to predict morphine requirements; however, age is the most consistent and well documented.¹² Preoperative coping strategies and lack of distress have been shown to predict morphine consumption in patients undergoing abdominal gynaecological operations³¹ and preoperative pain and anxiety³² have been shown to predict an increased risk of postoperative pain.

We propose that the rapidly increasing demand for morphine seen during the three first days post burn should be compensated for by increases in bolus doses. To make the best use of a PCA device it is essential to calculate the relation between doses of morphine requested and delivered. If the number of doses requested exceeds the number delivered, the patients become frustrated, and may increase their reports of pain. However, we do not think that increased consumption of morphine is the sole solution to the problem of pain in our burned patients. Other important pathophysiological explanations, such as destroyed nerves, which may lead to a neurogenic component of pain, is probable. This is supported by the fact that the pain of burns at times seems to be opioid-resistant, and at the same time seems to respond to other pain-relieving drugs. We currently have used a strategy which we think contributes to an

improved pain control, adding drugs, for example non-steroidal anti-inflammatory, or drugs that have claimed anti-neuropathic effects, such as the tricyclic antidepressant amitriptyline.

In conclusion: background pain can be treated adequately with PCA using a standard postoperative protocol and morphine. In contrast, control of pain during mobilization was inadequate. Severe pain during mobilization did respond poorly to increasing doses of morphine during the study period. Further refinement of the protocol or addition of drugs using other pain-relieving mechanisms may be needed to improve its management.

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Figure 1. Box and whiskers plots showing doses demanded during the study period.

□ = mean; Box = mean (\pm SE); and error bars indicate SD.

